PESTS NOT KNOWN TO OCCUR IN THE UNITED STATES OR OF LIMITED DISTRIBUTION, NO. 54: RICE BACTERIAL LEAF BLIGHT

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Disease

RICE BACTERIAL LEAF BLIGHT

Pathogen

Xanthomonas campestris pv. *oryzae* (Ishiyama) Dye

Selected Synonyms

Xanthomonas oryzae (Uyeda and Ishiyama) Dowson
X. translucens (Jones, Johnson, Reddy) Dowson f. sp. *oryzae* (Uyedo and Ishiyama) Pordesimo
Kresek disease

Class Order: Family

Schizomycetes: Pseudomonadales: Pseudomonadaceae

Economic Importance

In India, yield reductions of 6-74 percent were observed in 19 high yielding rice varieties infected with *Xanthomonas campestris* pv. *oryzae* (Ahmed and Singh 1975). Typical yield losses in India range from 6 to 60 percent in the different rice-growing regions (Ou 1972). In Japan, yield reductions of 20-30 percent have been observed when infection was moderate with losses over 30 percent occurring in years with severe infection (Mizukami and Wakimoto 1969).

Hosts

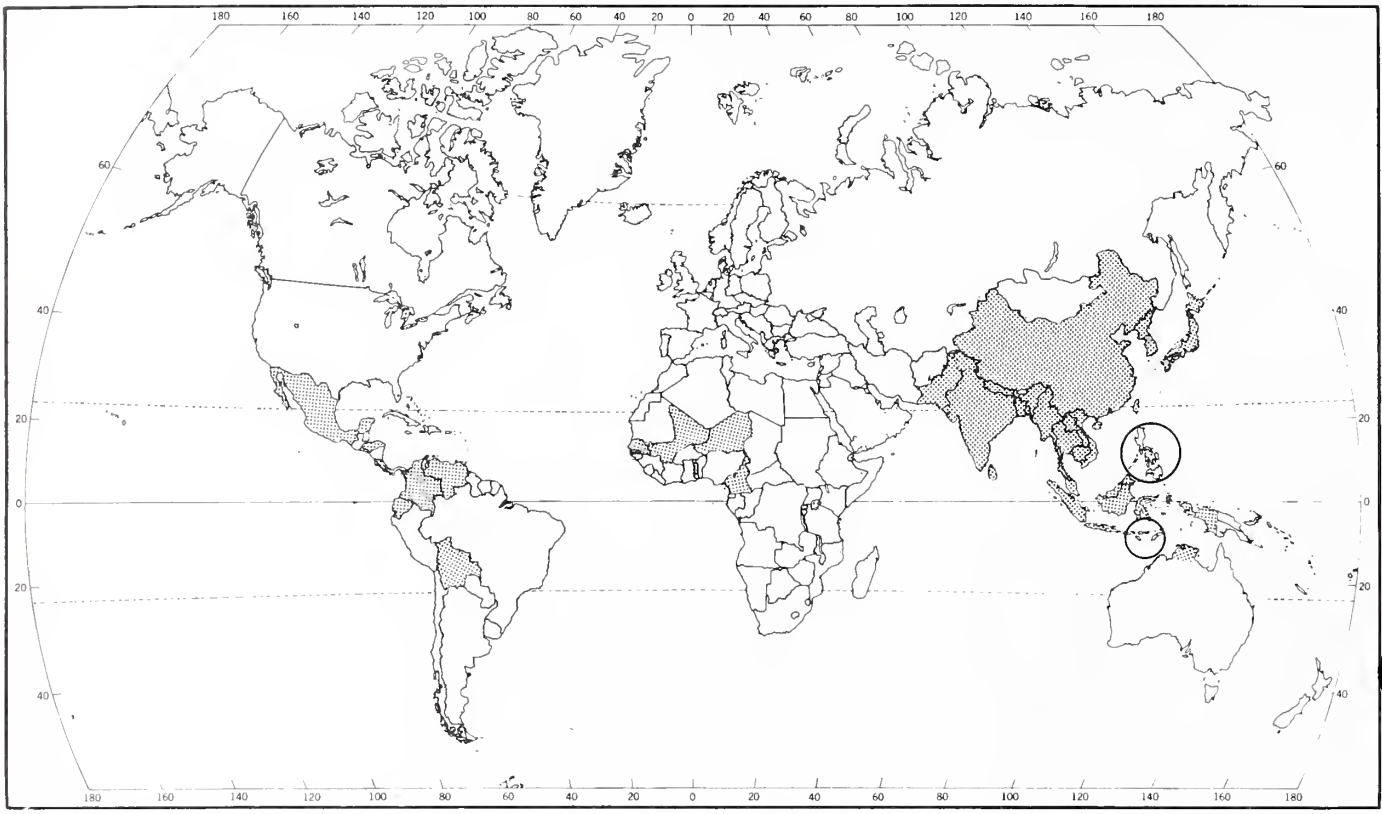
Xanthomonads are generally very host specific. *Oryzae sativa* (rice) is the only crop host. Additional hosts are *Leersia oryzoides* (rice cutgrass), *Leersia oryzoides* var. *japonica* (rice cutgrass), *Leptochloa chinensis*, *Leptochloa filiformis* (red sprangletop), *Leptochloa panicea*, *Oryza barthii*, *O. longistaminata*, and *Zizania latifolia* (Manchurian wildrice) (Buddenhagen 1982, Thri Murty, Devadath, and Rao 1982, Ou 1972, Srivastava 1972).

General Distribution

Bacterial leaf blight of rice is known to occur in Australia (Northern Territory), Bangladesh, Bolivia, Burma, Cameroon, China (including Taiwan), Colombia, Costa Rica, Ecuador, El Salvador, Honduras, India, Indonesia, Japan, Kampuchea, Korea (North and South), Laos, Malaysia, Mali, Mexico, Nepal, Niger, Panama, Pakistan, Philippines, Senegal, Sri Lanka, Thailand, Togo, Venezuela, and Vietnam (Buddenhagen 1982, Commonwealth Mycological Institute 1982).

Characters

Gram-negative, aerobic, nonspore-forming, capsulate rods 0.5-0.8 X 1.3-2.2 µm in culture, and 0.45-0.60 X 0.65-1.4 µm from host tissue (Ou 1972).



<u>Xanthomonas</u> <u>campestris</u> pv. <u>oryzae</u> distribution map prepared by Non-Regional Administrative Operations Office and Biological Assessment Support Staff, PPQ, APHIS, USDA

Growth at 10-40° C, optimal range 26-30° C (Ou 1972). Colonies on nutrient agar circular, smooth, convex, opaque, whitish yellow at first, straw yellow later. Growth slow, colonies appear in 3-4 days, diameter 1-2 mm after 5-7 days. On potato sucrose agar, colony honey yellow, diameter 1-2 mm in 3-4 days (Bradbury 1970).

Characteristic Damage

Symptoms develop on the leaves, leaf sheaths, and sometimes on the grain. The lesions begin as water-soaked stripes on the margins of the leaf blade, starting from the tip and extending downwards. The lesions turn yellow and enlarge in length and width, usually leaving a green area in the center of the leaf (Fig. 1). As the disease advances, the lesions cover the entire leaf blade and turn whitish. On susceptible hosts, the leaves roll, wilt, and dry. The

lesions extend to the leaf sheath where they may reach the lower end. Discolored spots with water-soaked margins sometimes appear on the glumes of the grain. These spots become gray or yellowish white when the grain matures.

(Fig. 1)

Bacterial leaf blight of rice showing infected leaves (Reproduced by permission of Commonwealth Agricultural Bureaux, SL2 3BN, UK).

In severe cases an additional phase of the disease is characterized by 'kresek' symptoms (Fig. 2). Leaves become grayish green and roll up along the midribs and wither. Eventually, infected plants either die or remain stunted and yellowish green (Moffett and Croft 1983, Ou 1972, Mizukami and Wakimoto 1969).

Yield losses caused by bacterial leaf blight result from a combination of factors. The disease increases the number of sterile florets and underdeveloped or unfilled grain, which in turn reduces the 1,000-grain weight. In very susceptible varieties, whole panicles may be killed (Ahmed and Singh 1975).

(Fig. 2)

Bacterial leaf blight of rice showing varietal reactions at seedling stage. From left, very susceptible (kresek symptoms), susceptible, and most resistant (Reproduced by permission of Commonwealth Agricultural Bureaux, SL2 3BN, UK).

Bacterial leaf blight differs from bacterial leaf streak caused by Xanthomonas translucens f.sp. oryzicola (Fang et al.) Bradbury. In leaf streak, numerous dark green, water-soaked streaks of various lengths appear between the veins. These later turn brown and may coalesce. The lesions are scattered on the leaf blade and not confined to the margins as in the early stage lesions of bacterial blight. Wilting and stunting are not often associated with leaf streak (Ou 1972).

Detection Notes

1. Xanthomonas campestris pv. oryzae could enter the United States in paddy rice (unhulled seed) in which it can survive for at least 11 months (Singh and Rao 1977). Paddy rice is prohibited entry from all foreign localities, except Mexico. Paddy rice from Mexico can enter only under a USDA departmental permit. Inspect samples of hulled rice for contamination with paddy rice.

2. The bacteria can survive in rice straw for at least 4 months (Mizukami and Wakimoto 1969). Rice straw used for packing material is prohibited entry under Title 7, Part 319.69 of the Code of Federal Regulations. Rice straw imported for commercial use requires a permit and a USDA approved treatment as a condition of entry. The bacteria can also enter in infected rice plants or soil, both of which are prohibited entry without a permit under Federal regulations.

3. In the field, look for lesions on one or both edges of the rice leaf with a green area in the middle. The lesions can be yellow or white with wavy margins, and can be dotted with gray or black saprophytic fungi. Small opaque drops of bacterial exudate may be observed on lesions in the morning.

4. Note that the leaves of severely affected plants may turn grayish green and roll up along the midrib. These plants may wither and die or remain stunted and yellowish green. The entire field may show uneven growth (Ou 1972).

5. Microscopic examination of the cut end of a diseased leaf specimen in water will reveal the outpouring of a cloud of bacterial cells from the host tissue (bacterial streaming). A water drop on the microscope slide will become turbid within 10-15 minutes from the bacterial streaming. The pathogen can easily be isolated from this water drop by streaking on nutrient agar (Srivastava and Rao 1966).

Bacterial streaming can be observed in either fresh or dried specimens. It provides a very easy method for detecting systemic bacterial infection.

6. Plant material suspected of infection with *X. campestris* pv. *oryzae* should be dried and pressed when submitted for identification.

Biology and Etiology

Xanthomonas campestris pv. *oryzae* overwinters in a number of different habitats which provide the primary inoculum for infection. In Japan, the weed host *Leersia oryzoides* var. *japonica* provides an overwintering habitat. The pathogen survives in the above- and below-ground stem parts and rhizosphere of this weed host. The bacterial population increases rapidly in March on newly developed roots and emerging stems.

The pathogen also overwinters in rice straw which is piled in the fields. The bacteria die within 1-2 months if this straw

is plowed into the soil. Surviving rice stubble provides an additional overwintering habitat for the pathogen. In the spring, the bacteria multiply in emerging tillers and developing roots of the rice stubble (Tagami, Kuhara, and others 1963). Volunteer rice seedlings provide a primary source of inoculum especially in areas where two crops are grown each year (Thri Murty and Devadath 1981).

Bacteria also survive in the husks of rice seeds. Although this source of inoculum declined steadily, infection by seedborne bacteria continued for up to 11 months after harvest (Singh and Rao 1977).

X. campestris pv. *oryzae* can infect rice plants through the roots and leaves. Leaf infection takes place primarily through the hydathodes, which are water glands connecting the vascular system with the leaf surface. Each hydathode opens to the upper leaf surface through 5-25 water pores (40-50 µm in diameter) and connects to the vascular system by way of loose specialized mesophyll tissue called epitheme. Bacteria enter through the water pore, multiply in the epitheme, and invade the vessel. Other bacterial cells ooze through the water pore as droplets on the leaf and serve as inoculum for secondary infection (Tabei 1977).

Heavy multiplication of bacteria in the vascular system can cause a blockage of water flow and subsequent wilting. Seedlings wilt within 2 weeks following inoculation with the blight pathogen (Tabei 1977).

X. campestris pv. *oryzae* can also infect through the stomata. This pathway does not result in the development of external symptoms because the vascular system is not invaded. Instead, the pathogen multiplies in the intercellular spaces of the mesophyll. The bacterial cells then exude onto the leaf surface where they may reinfect through the hydathodes or be disseminated to other rice leaves or plants.

Wounds also provide a means of entry for the bacterial pathogen. In certain rice-growing areas, seedlings are pruned to avoid lodging. The bacteria can enter directly through the leaf wounds (Dutta and Rafey 1982). Root wounds also provide a mode of entry for the pathogen. When the root tips of rice seedlings were cut and the plants dipped in a bacterial suspension for 2 or more hours, disease symptoms and wilting followed (Srinivasan and Singh 1981). Transplanting of rice seedlings wounds the roots and provides a mode of entry for the bacterial blight pathogen.

Typhoons and rainstorms are a major factor in disease dissemination in Asia. The winds and rain spread the pathogen and wound the rice plants, facilitating infection. The disease is more severe in years with prolonged heavy rainfall (Srinivasan and Singh 1983).

The bacteria also move in irrigation water or paddy flood water. Fields with severe infection in the Philippines had bacterial populations of 100,000 cells per milliliter of flood water. In Japan, disease severity increased in locations that were low, wet, poorly drained, and subject to frequent flooding (Ou 1972). The incidence of wilt was six times higher in fields with 8 cm of standing water compared with fields with saturated soil but no standing water 30 days following seedling transplanting (Srinivasan and Singh 1983).

The bacterial inoculum found in the irrigation and flood water is derived from the drops of bacterial ooze exuded from the rice leaves, and from the stream of bacterial cells coming from plant wounds. Survival of the bacteria was longer in rice paddy water at lower temperatures. At 30° C the pathogen remained viable for less than 6 days in the water. At 20° C viability continued for almost 12 days, and at 10° C for 37 days (Hsieh and Buddenhagen 1975). Bacteria in irrigation and flood water are the most important source of inoculum for secondary infection and dissemination of the disease.

Warm temperatures during the crop season favor development of bacterial blight of rice. Disease was most severe at 25-30° C in inoculated seedlings. No disease developed at 17° C (Ou 1972).

Control

Use of rice cultivars resistant to endemic strains of _X. campestris_ pv. _oryzae_ is the best means of control. There is a broad range of resistance to bacterial blight among the thousands of rice cultivars.

The disease is perpetuated between crop seasons in rice stubble, straw, plant debris, and ratoon plants (sprouts that emerge from roots after cropping). Good phytosanitary methods, such as burning or plowing host material under the soil, are helpful.

Certain weed hosts, such as _Leersia_ spp., are important in the overwintering of the pathogen. Eradication of weed hosts reduces bacterial inoculum (Tagami, Kuhara, and others 1963).

Excess nitrogen fertilization favors disease development and should be avoided. If cultural practices include transplanting of rice seedlings, irrigation levels should be kept as low as possible in the nursery area (Mizukami and Wakimoto 1969).

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